



# Occupant Centric Integrated Survivability



***TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.***

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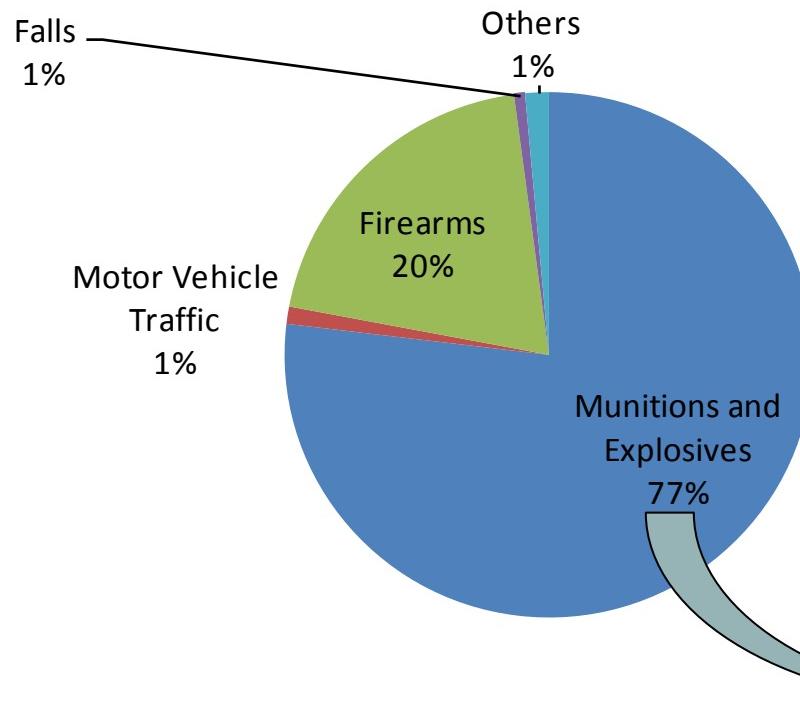


# Purpose

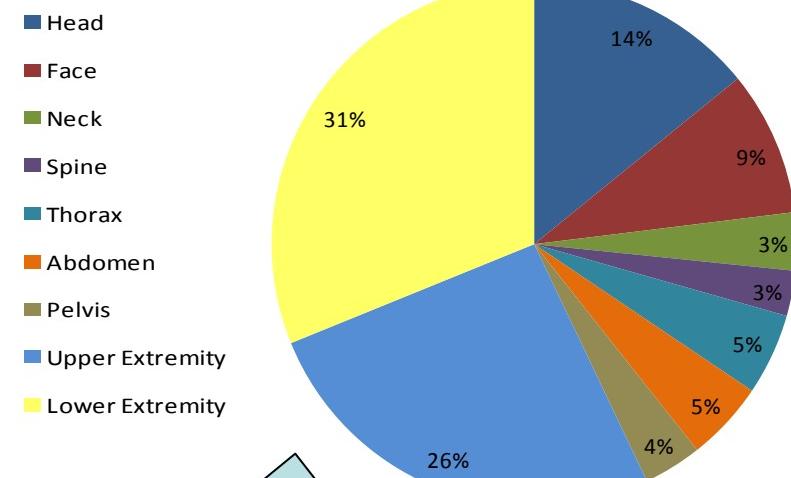


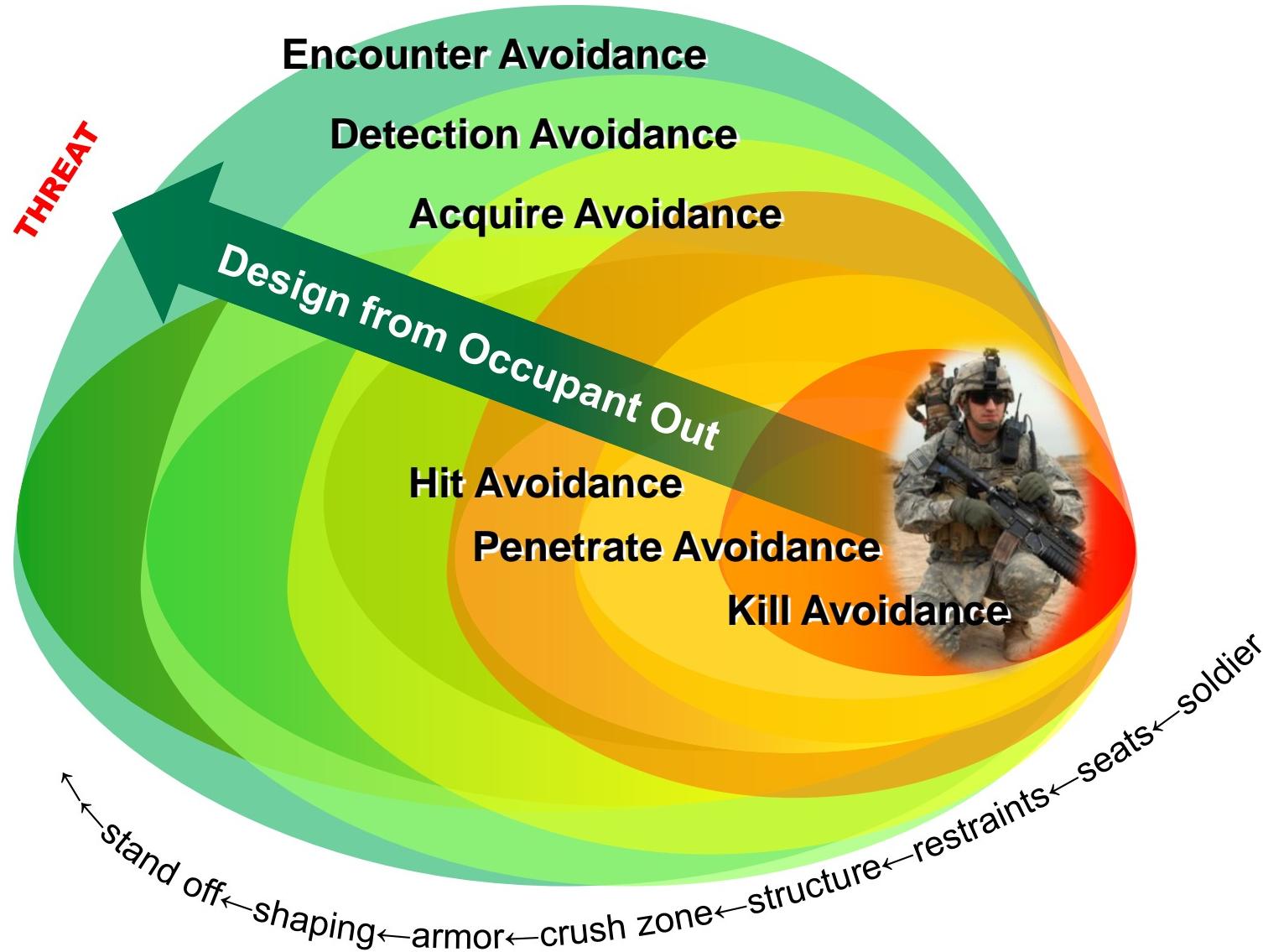
**Understand how to balance vehicle  
“protection”, “performance” & “payload”  
through an integrated survivability  
approach that starts with occupant  
protection.**

## Cause Agent Breakdown 2002-2008



## Munitions & Explosives Injuries by Body Region





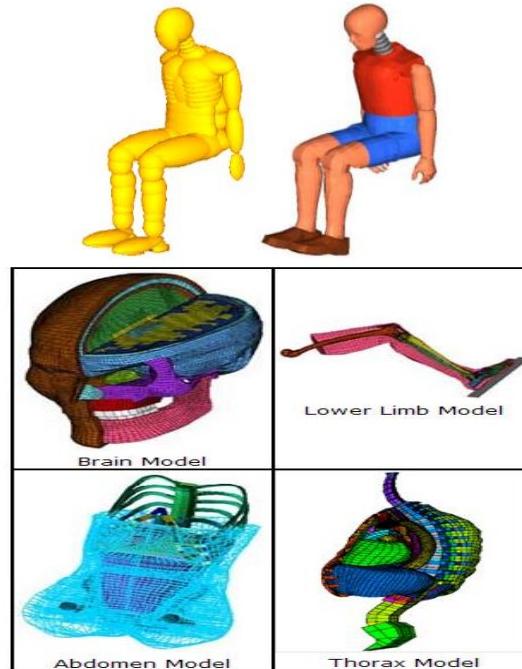


# Building Blocks for Occupant Centric Design

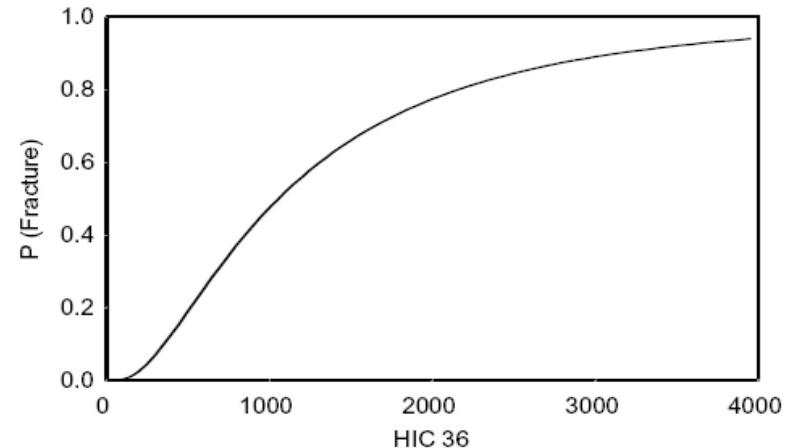


- 1. Requirements – Injury Criteria....what are we willing to accept?**
- 2. Platform Constraints**
- 3. Occupant Packaging**
- 4. External Threat Conditions**
- 5. Technology/Design Standards Implementation**
- 6. Space, Weight, Power, Cooling (SWaP-C)**
- 7. Concept Substantiation**
- 8. Prototype & Test**

## Injury Assessment Tools



## Example of One Criteria – Head Injury Criteria

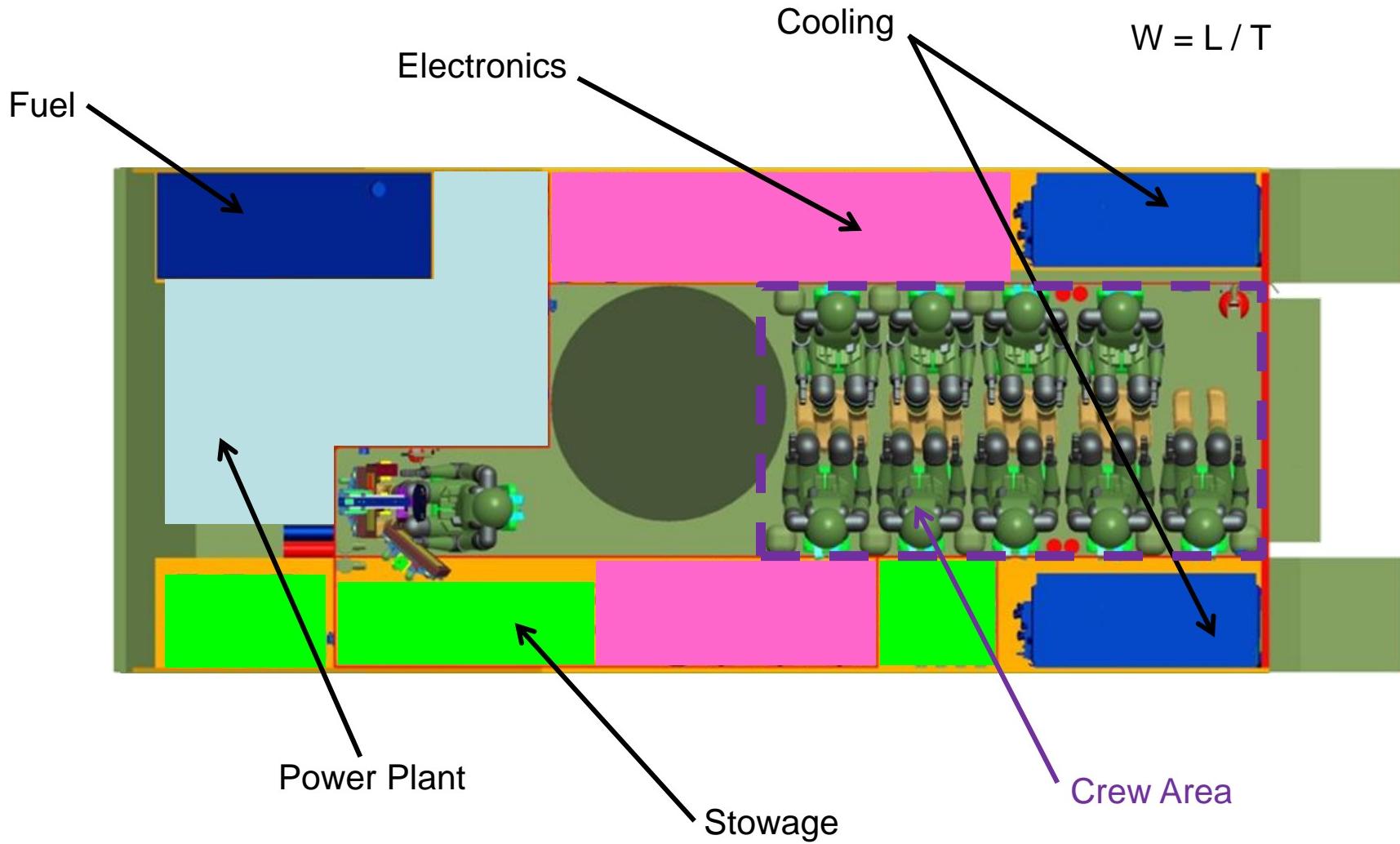


$$HIC = \left[ \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} adt \right]^{2.5} (t_2 - t_1)$$

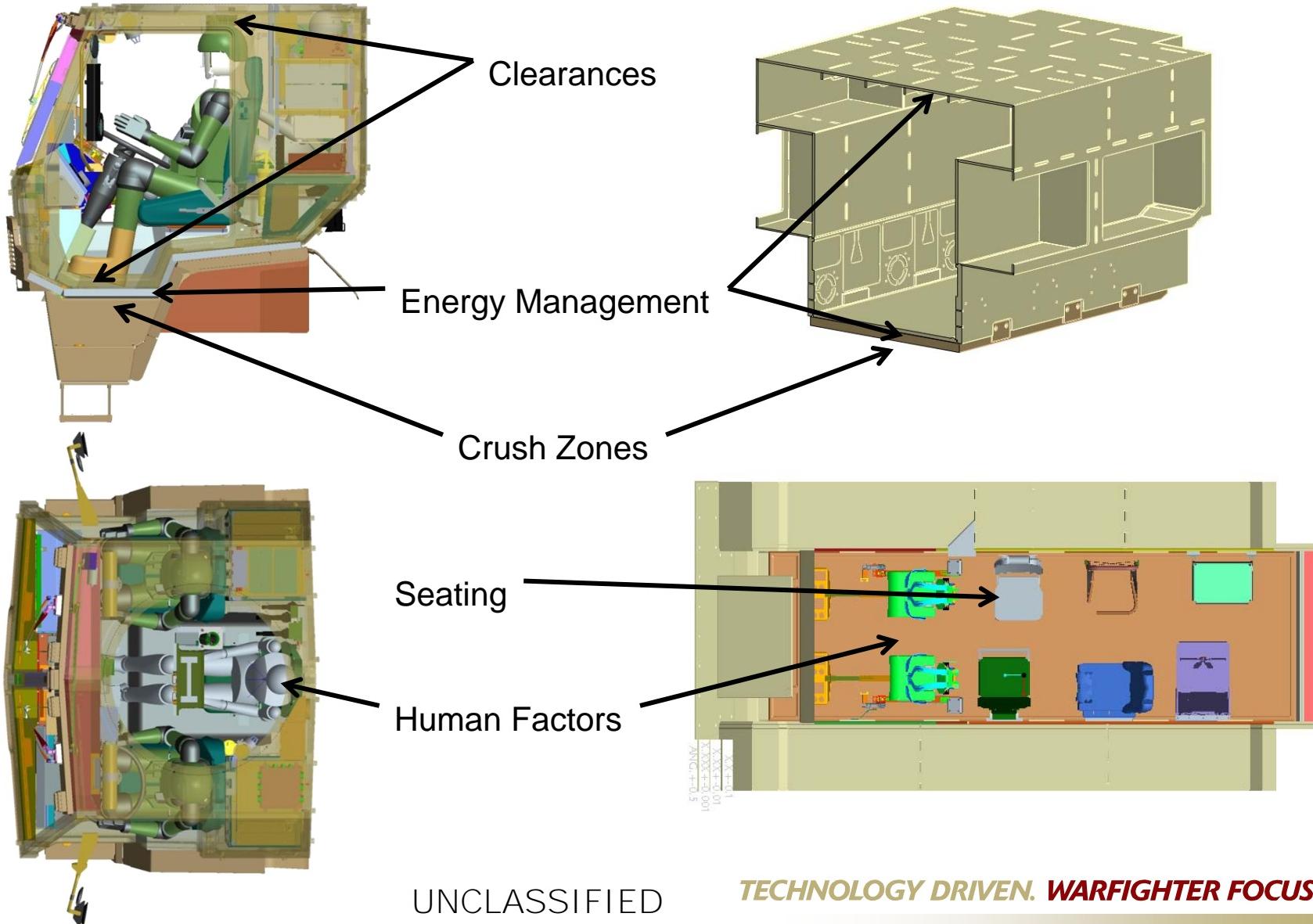
**Using analytical instrumented test devices, we can determine occupant injury response & subsequent risk acceptance**

## 2. Platform Constraints

### Example Personnel Carrier



### 3. Occupant Packaging



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**Stand-Off**



**Blast**

**Employment**



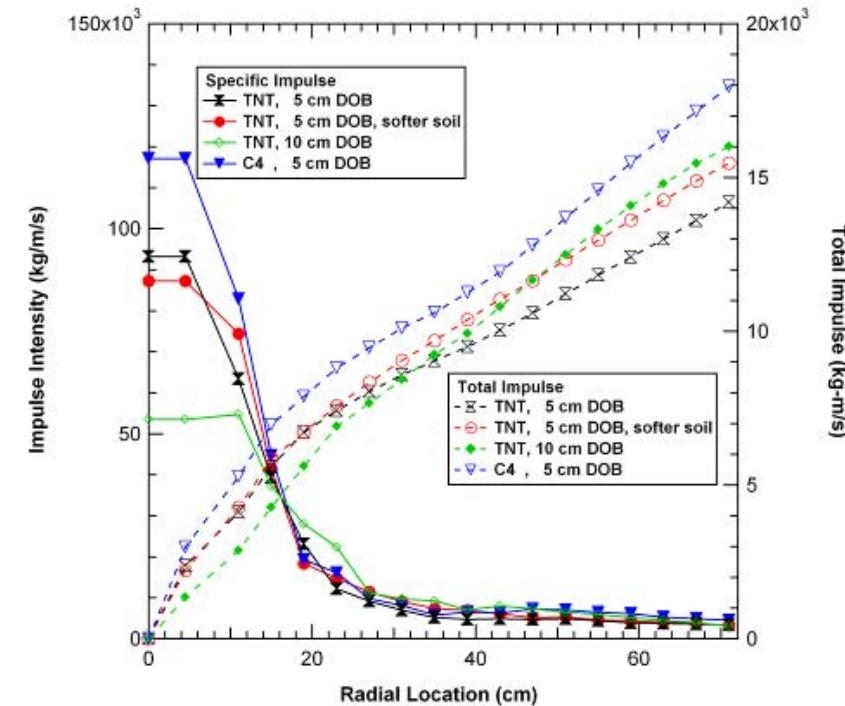
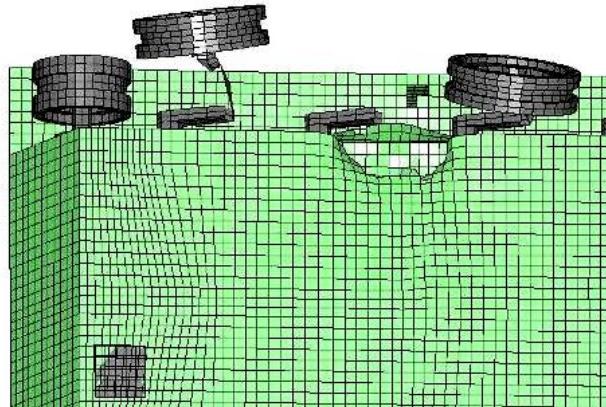
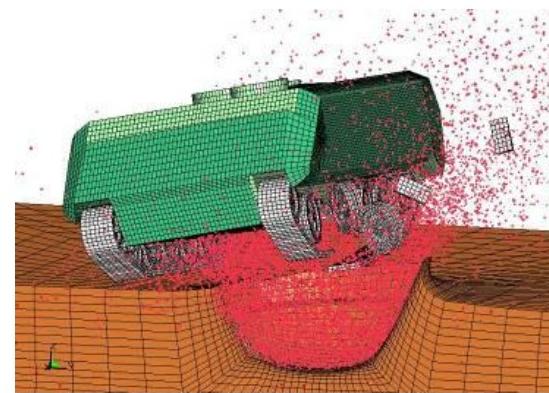
**Fragments**



**Size (kg's)**

**What are we concerned with?**

## 5. Technology/Design Standards Implementation

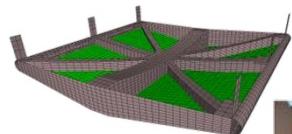


Based on injury criteria, platform constraints, occupant packaging, external threat conditions, we model the baseline effects and resultant occupant injury

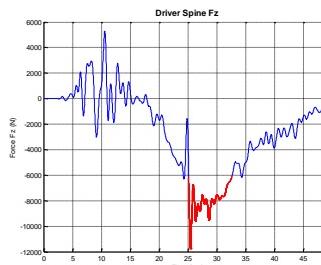
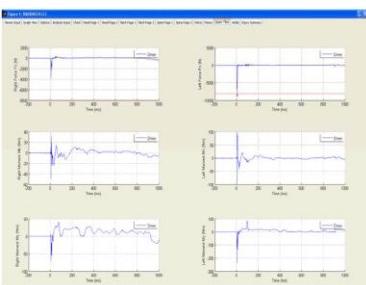
## 5. Technology/Design Standards Implementation

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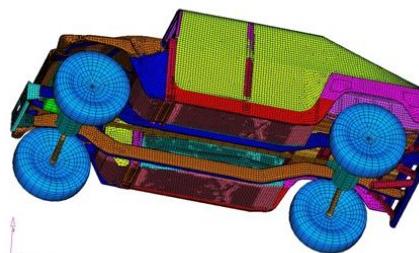
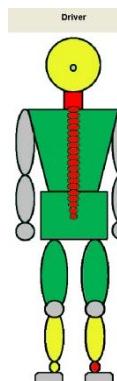
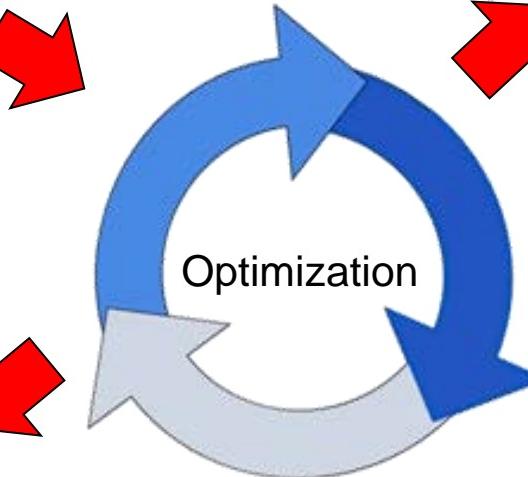
### Technology/Design Standards Introduction



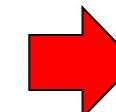
### Injury Analysis



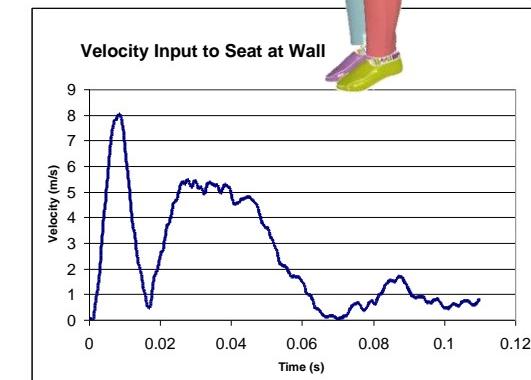
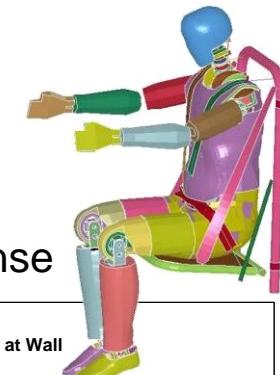
| Criterion                          | Symbol  | Threshold Values                            | Driver   |          |      |           |
|------------------------------------|---------|---|----------|----------|------|-----------|
|                                    |         |   | Value    | Duration | IARV | Pass/Fail |
| Upper Neck Nij                     | Nij     | Nij >= 1                                    | 1.28     | 0.00     | 128% | Fail      |
| Upper Neck Tension Curve           | +Fz (N) | 4170N @ 0ms, 3670N @ 35ms, 1100N @ 60-100ms | 4162.27  | 0.00     | 127% | Fail      |
| Upper Neck Compression Curve       | -Fz (N) | 4000N @ 0ms, 1100N @ 30-100ms               | 6108.00  | 0.00     | 153% | Fail      |
| Upper Neck Twist Moment            | Mz (Nm) | Mz  >= 78Nm                                 | 81.73    | 0.00     | 105% | Fail      |
| Spine DRiz                         | DRiz    | DRiz >= 17.7                                | 24.60    | 0.00     | 139% | Fail      |
| Spine Lumbar Compression Curve     | -Fz (N) | 6673N @ 0ms, 3800N @ 30-100ms               | 11708.41 | 0.00     | 175% | Fail      |
| Last Lower Tibia Compression Force | -Fz (N) | -Fz >= 6900N for 27yr old                   | 6977.90  | 0.00     | 101% | Fail      |



### Platform Response

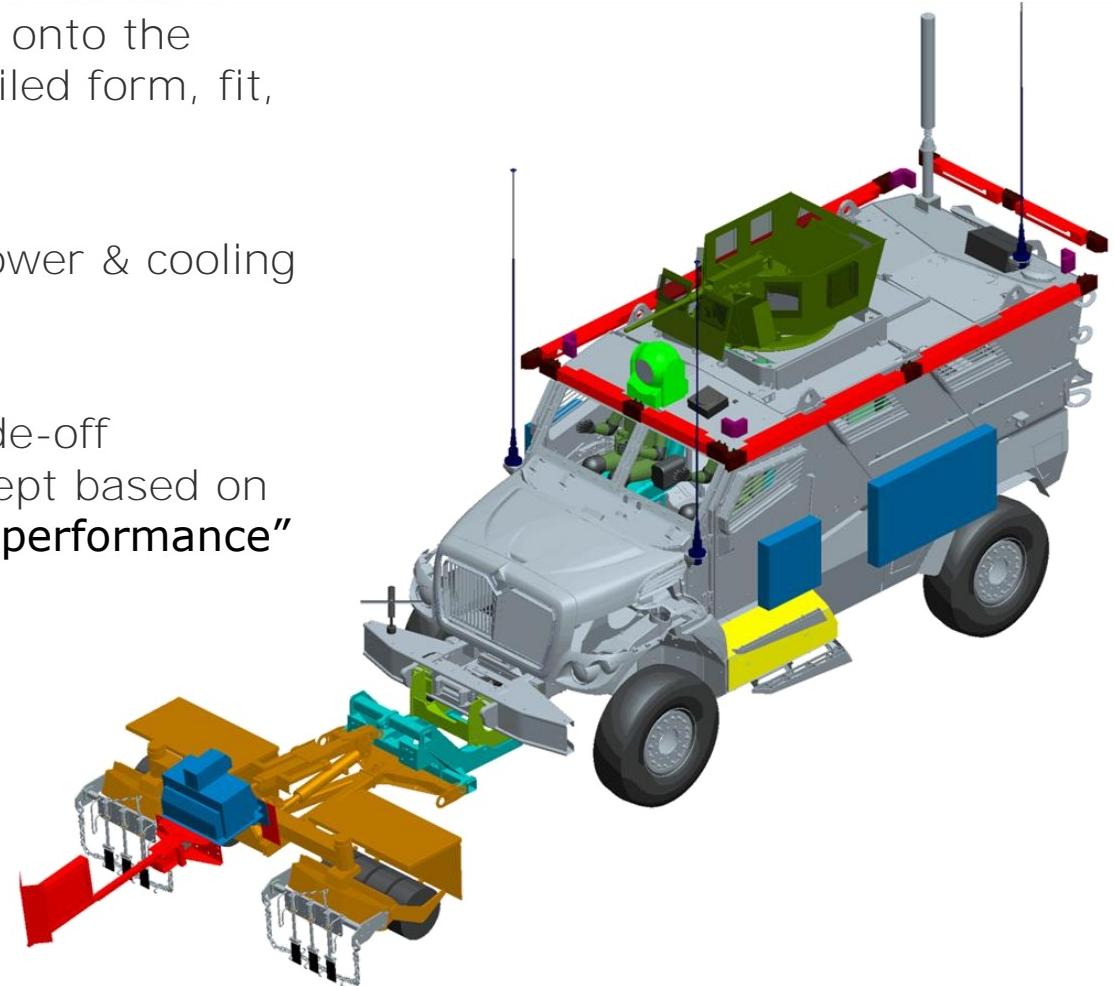


### Occupant Response

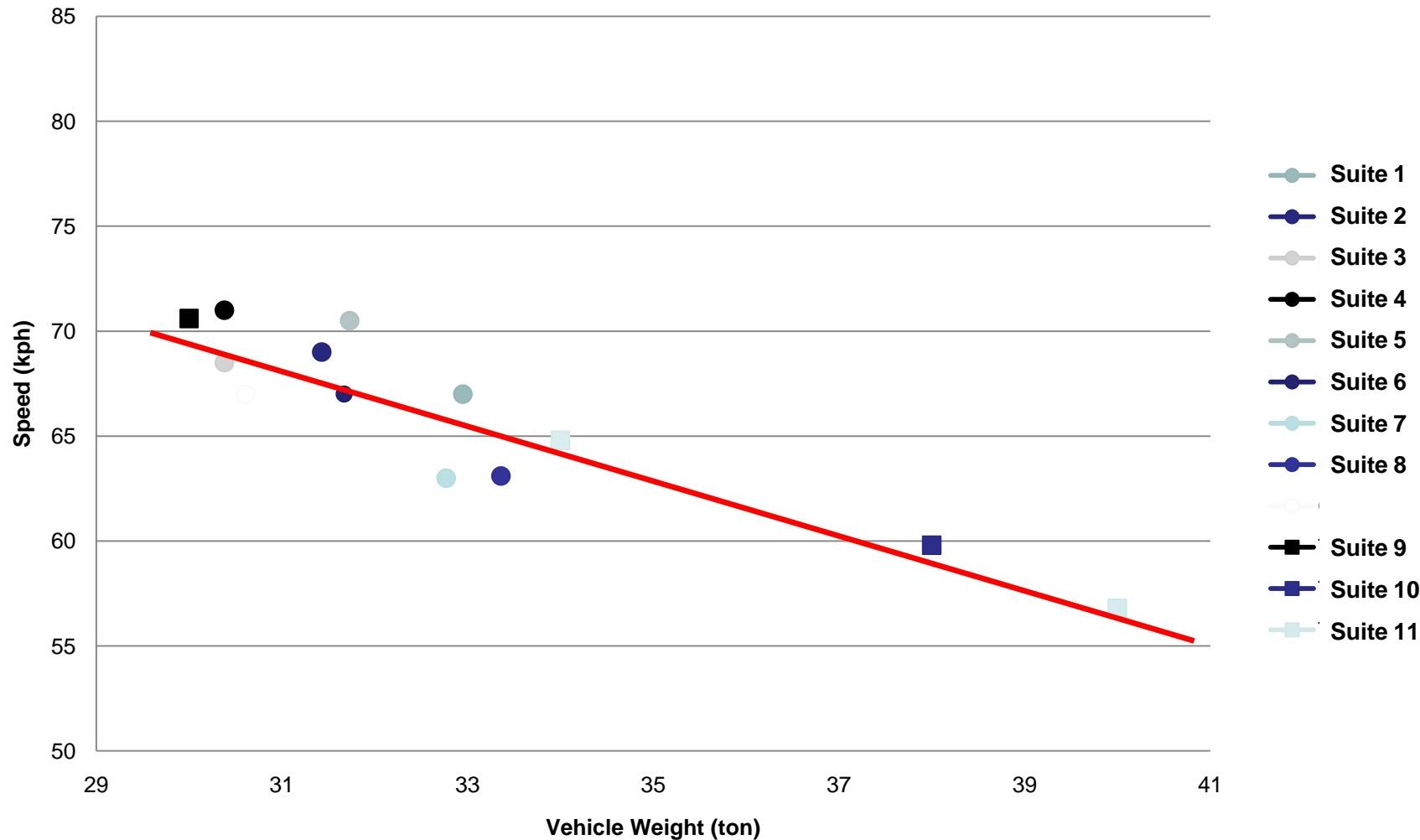


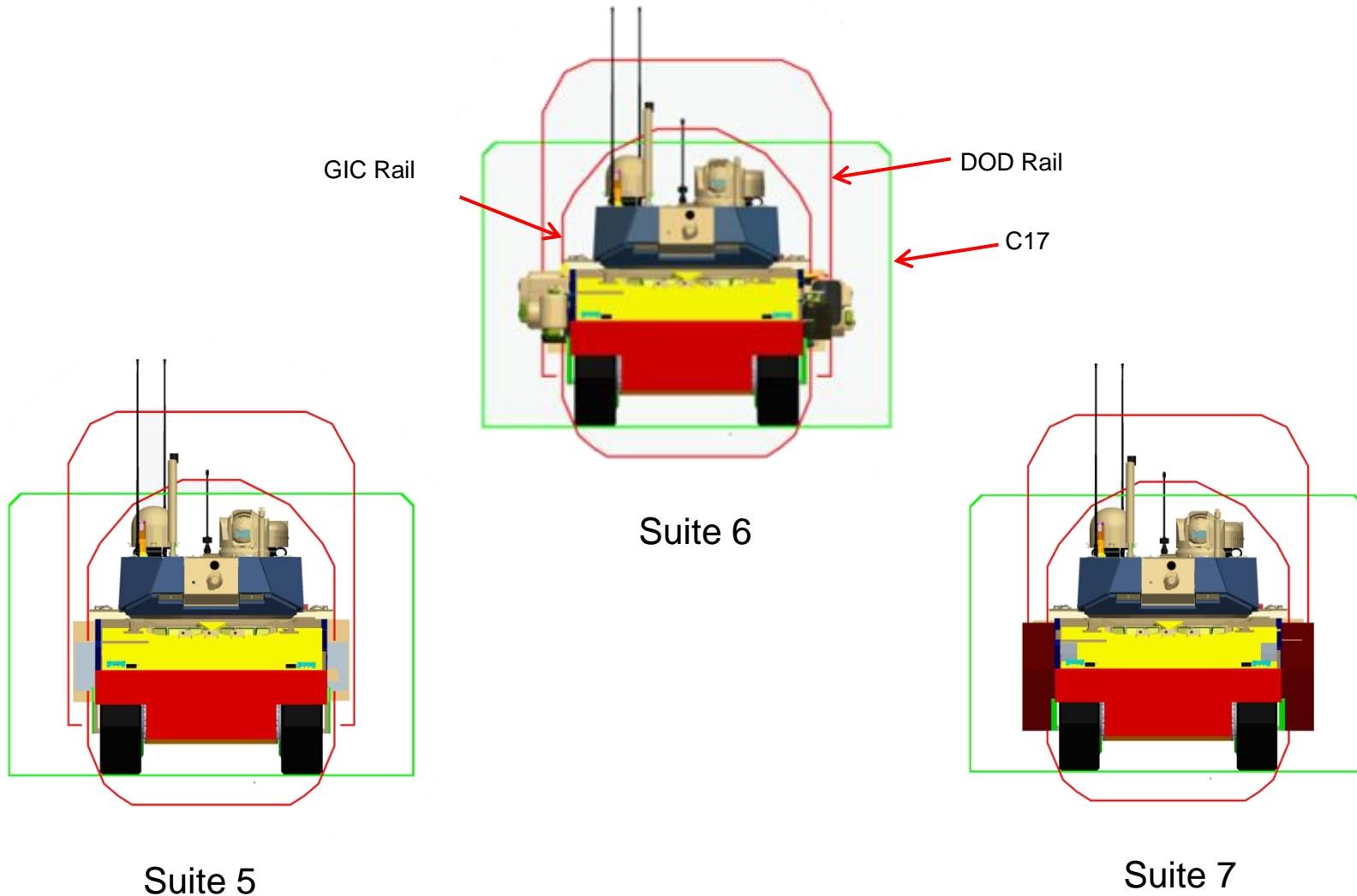
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- Proposed technologies and/or suites of technologies are integrated onto the candidate platform for detailed form, fit, function
- Begin the space, weight, power & cooling (SWaP-C) analysis
- Iterative physics based trade-off assessments to refine concept based on SWaP-C and “protection”, “performance” & “payload” .
  - Braking
  - Turning
  - Lane Change
  - Thermal Signature
  - Cooling
  - Acceleration
  - Data Flow
  - Human Factors
  - Power
  - Etc

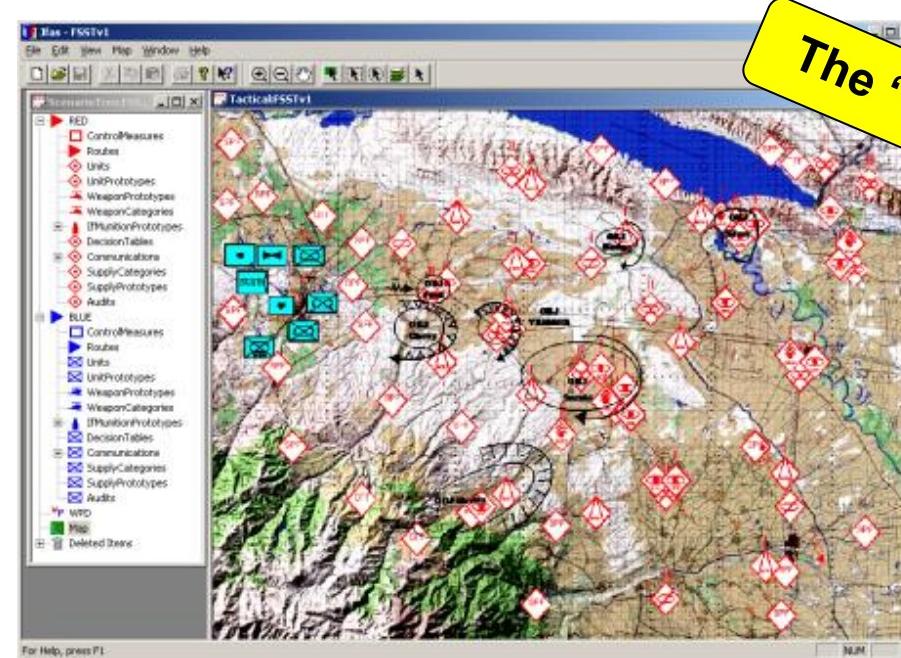
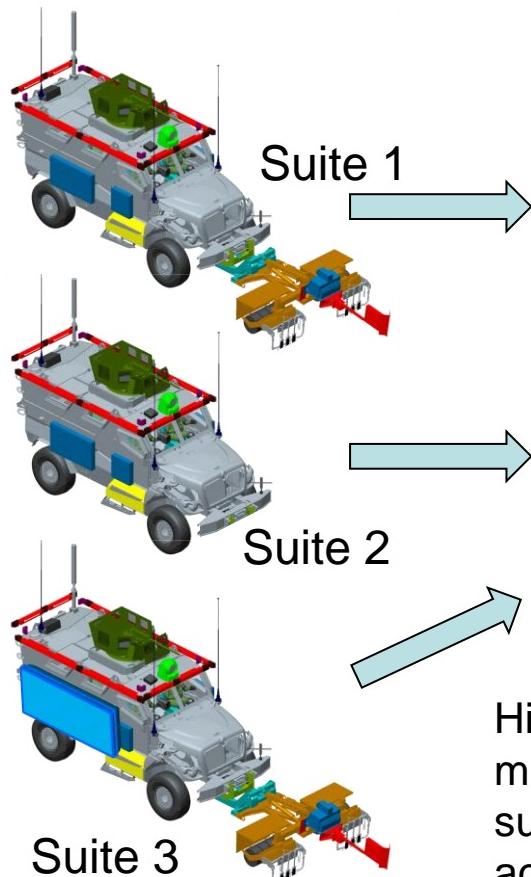


## Top Speed Decreases as Proposed Protection Suite (weight) Increases





## 7. Concept Substantiation



High resolution force-on-force model provides engagement results in multi-day scenarios. Assess loss exchange ratios resulting from survivability suite changes to the candidate platform(s) taking into account:

Environment  
Maneuver  
Engagement  
Engineer

Command & Control  
Surveillance  
Communications  
Rearm

Concept substantiation via operational force-on-force modeling address trades and suite composition with sufficient fidelity to capture synergy and interference among technologies:

- Compare relative benefits of various technologies – APS vs. soft-kill CMs;
- Identify optimum combinations of other-than-armor survivability concepts;
- Isolate contribution of specific technologies – SigMan, Smoke;
- Identify benefits of tactical countermeasures – cued counterfire, maneuver.
- Performance of suite combinations against specific threats;
- Benefits and burdens of survivability technologies – laser filters, active sensors;
- Effect of design decisions on overall survivability – APS dead zones, armor vulnerabilities.

## 8. Prototype & Test



Baseline Platform Assessment



Technology Fabrication/Integration



Subsystem Component Test



Full-Up System Assessment

# Conclusion

- The change in threat has necessitated a change in the way survivability is looked at.
- The Occupant Centric approach ensures we focus on the soldier first and build the necessary protection around the occupant from the inside out.
- The disciplined integrated survivability modeling process allows assessment of multiple survivability technologies over numerous threat environments in a manner providing system level technology contribution to survivability.
- The Occupant Centric approach optimizes & balances the critical attributes of system performance, payload & protection related to technology cost and risk, life cycle costs, and system burdens such as weight, volume, power, costs, or other quantifiable measures that impact the system or force.